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An intelligent Computer-to-Computer transmission package was designed and implemented using the PROCOMM PLUS communications program to transfer data from one computer to another. The package permits a noncomputer literate person to accomplish communications tasks. The package provides automatic: adjustment of baud rate, communications port number, data compression/decompression, single or multiple file transmission, and communications protocol handling. The package is designed for Hayes compatible modems and transfer of graphic, text, or binary data.

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An Intelligent Computer-to-Computer Transmission Package

by Marcelle Hajjar and Peter Frasca

With the advent of personal computers (PCs), the ability to communicate with them has become both an asset and a liability. For the computer-literate user, the PC is an asset that is an invaluable tool for communication. But for the noncomputer-literate person, anything less than simple programmed keystroking is a liability. Generally speaking, the noncomputer literate user does not want to focus his attention on learning computer software manipulation and the essential associated details. Fortunately, we are in a period of ongoing hardware and software development in telecommunications technology that enables the programmer to provide intelligent software systems that permit noncomputer literate to accomplish communications tasks that only the sophisticated user could accomplish only a few years ago.

About three years ago, the U.S. Air Force began fielding a new generation of tactical communications equipment (TRI-TAC) which greatly enhanced its ability to communicate logistically and tactically. However, because of a diversity of equipment, lack of interoperability data, and various levels of computer literacy among the ranks of its personnel, maximum utilization of the equipment was not possible.

The task of finding a solution for this problem was taken up by the U.S. Air Force's Electronic Systems Division's (ESD's) *Integration Division* located at Hansom AFB. The division was led by George Mamalis. He and his staff were constantly faced with the task of responding to requests for interoperability data from system users.. TAC users were frustrated in their attempts to utilize the communications system. Too often they had incomplete and, in some cases, conflicting interoperability data. The *Integration Division* realized that it needed a continuously updated master data base that kept track of all equipment being fielded and data about its interoperability requirements/problems. A much needed data base had to be developed that would identify the equipment, its location and, most importantly, its interoperability requirements and capability.

Establishing and maintaining the data base presented no major problem. The *Integration Division* would create it and maintain it. The problem was to make the data base available to all TAC users who used a variety of IBM-compatible and lap-top PCs, and to be sure that all TAC users worked with current data. As Mr. Mamalis described it, "I want a system that automatically makes it possible for people like myself and my secretary to service data requests by simply identifying the data to be sent on the screen and then pressing a key. I want to keep it simple."

To meet this need, an intelligent computer-to-computer transmission package was designed and implemented using the PROCOMM PLUS communications program. The package is designed for Hayes compatible modems and has been tested using four different types.

The data transmission package features the following capabilities:

* Automatic adjustment of the baud rate on the communication screen if the detected baud rate differs from that specified.

* Automatic adjustment of the communication port number on the communication screen if the detected active port differs from that specified.

* The communication protocol is handled by the program.

* Automatic transmission of a single file or all files in a subdirectory.

* Automatic compression of data before transfer and automatic decompression of data after transfer.

* Data can be: graphics, text or binary.

* Data can be transferred using a Hayes-compatible internal or external modem.

The developed package consists of DIAL, ANSWER, SENDER, RECEIVER, and HANG-UP modules to establish a data link and automatically transmit between computers.

Module Functions

* DIAL module detects dial tone, dials number, sets modem wait time for carrier signal.

* ANSWER module sets modem register to specified number of rings before answering telephone.

* SENDER and RECEIVER perform data transfer.

* HANG-UP module sends command to disconnect the line at completion of transmission.

Automated Functions

This intelligent computer-to-computer software program offers the experienced and inexperienced user the following advances in more efficient, accurate and timely data transmission:

* Users do not have to know how to use PROCOMM PLUS, communications ports or modems in order to use the software package. However, the user is given the option to define the communication port number and the desired modem baud rate.

* When the DIAL or ANSWER module is activated, it detects if the defined port is incorrect, searches for a port that is connected to a modem, informs the user about the correct port number, adjusts the port number, and dials automatically.

* Due to variable modem characteristics, the defined baud rate may change when the data link between the two computers is established. The software automatically compensates for this. Table 1 summarizes the behavior of different types of modems using different speeds. For example, if both ends use the same type of modem (U.S. Robotics 2400 Baud Sportster), and the dial station uses a baud rate that is different than the answer station, the baud rate of the dial station will override it and become the data link speed. However, if the local-end uses one type of modem (U.S. Robotics 2400 Baud Sportster) and the distant-end uses another type of modem (SWAN 2400i), and the dial station uses a different baud rate than the answer station, the data link speed will be either as defined by the dial station or as defined by the answer station. Another variable also comes into play when one end uses a modem that operates only at one speed, whereas the other end uses a modem that operates at more than one speed. The data link speed will coincide with the speed of the modem that operates at one speed.

* For any of these situations, the software detects the established data link speed, prompts

the user with the cause of the baud rate change (i.e., to either conform to the modem requirements or to the distant-end baud rate requirements), and automatically adjusts to the established baud rate.

* When the line connection is established, data can be transferred back and force between two computers by using the SENDER and RECEIVER modules.

* The sender and receiver modules begin checking the communication line to confirm line status. If the line is OFF, the modules will prompt the user of the line status and quit. Otherwise the sender starts by sending the "READY TO SEND" signal and waits for a response from the receiver. If the receiver responds with the "READY TO ACCEPT" signal, the sender prepares the data to be transferred by pointing to the place where the data is stored, compressing the files to reduce the transfer time, and waiting for a "READY TO ACCEPT" signal from the receiver. Simultaneously, the receiver points to the temporary directory that is created to hold the transferred data, cleans this temporary directory of any previous transfer, sends a "READY TO ACCEPT" signal to the sender, and awaits a "START" signal in order to receive the data.

* When the sender receives the "READY TO ACCEPT" signal from the receiver, it initiates the "START" signal, transmits the data, sends the result of the data transfer (i.e., whether transfer is complete at the sender-end or aborted) to the receiver, and waits for the transfer status from the receiver. The receiver in turn receives the "START" signal, receives the transferred data , receives the result of the data transfer from the sender, sends the result of the data transfer (i.e., whether transfer was completed at the receiver-end or aborted) to the sender, and decompresses the transferred data. At any stage in the transmission, if there is an interruption in transmission of any kind such as a break in the line, the signal was not received within the specified time, noise which created an invalid signal etc., the software detects the interruption and displays its cause to the user.

* When the HANG-UP module detects an abort command, it disconnects the line.

The communication software was written to operate with Hayes compatible modems using PROCOMM PLUS script language. It was tested in the ACER 1100, KAYPRO 2861, TOSHIBA 286 (lap-top) and ZENITH 150 computers using the following internal modems:

1- U.S. Robotics 2400 Baud Sportster
2- MultiModem 224E 2400 Baud
3- SIGNALMAN MARK XII
4- SWAN 2400i

Testing revealed that communications were unreliable when using external modems.

In order to make the modems communicate as an integrated system, it was essential that the software be designed to adapt to all modem operating conditions. Because of the different operating characteristics of the modems, software adjustments were necessary. Comparisons of the modem characteristics are listed in Tables 1, 2 and 3.

The tested modems did not operate in the same way for the following reasons:

1- **Setting of modem registers is not the same for all modems.**

Table 2 summarizes the behavior of the registers in the tested modems.

The "S0" register of the SIGNALMAN MARK XII modem controls the number of rings after which an automatic answer will occur. It is reset to "1" at power up. However, when using the U.S. Robotics 2400 Baud Sportster, MultiModem 224E, and SWAN 2400i modems, in which the "S0" register controls the number of rings after which an automatic answer will occur, the registers are reset to "0" at power up.

The "S1" register of the U.S. Robotics 2400 Baud Sportster, MultiModem 224E, and SWAN 2400i modems counts rings which have occurred. The "S1" register of the SIGNALMAN MARK XII modem is reset to the "S0" value following the "AT" (*command*) or at power-up and is decremented each time the telephone rings.

The "S7" register determines how long the modem will wait for a carrier signal before aborting the call. The "S7" range of the SWAN 2400i modem is (1-30) seconds, whereas it is (1-255) seconds for the MultiModem 224E, (0-255) for the U.S. Robotics 2400 Baud Sportster, and not available for the SIGNALMAN MARK XII modem.

2- **Commands are available for one modem, but not available for others.**

Table 3 summarizes the command comparisons of the tested modems.

The dial tone mode command and the audio monitor control command are available for U.S. Robotics 2400 Baud Sportster, MultiModem 224E, and SWAN 2400i modems; but they are not available for the SIGNALMAN MARK XII modem.

3- **Result modem code is not the same for all modems.**

The U.S. Robotics 2400 Baud Sportster, the MultiModem 224E, and the SWAN 2400i modems respond with a "BUSY" code if the telephone number dialed is busy. The SIGNALMAN MARK XII modem responds with a "NO CARRIER" code, if the telephone number dialed is busy.

4- **Command Syntax is not the same for all modems.**

Table 3 summarize the commands comparisons of the tested modem.

The U.S. Robotics 2400 Baud Sportster and the SWAN 2400i modems use a "W" command to wait for the dial tone. The MultiModem 224E uses a "B1" command which selects the wait for dial tone method. The "," causes the modem to wait for dial tone.

The U.S. Robotics 2400 Baud Sportster uses the ">" command to enter the repeat mode. After 10 failed dial attempts, the modem exits the repeat mode. The Multi-Modem 224E uses the "A:" command to continuously dial the last dialed number until it is answered or until any key is pressed.

5- **Modems do not behave the same way under a specific command.**

The MultiModem 224E, the SIGNALMAN MARK XII, and the SWAN 2400i modems use the "+++" command to bring the modem into the command mode while still remaining ON LINE. The U.S. Robotics 2400 Baud Sportster stays ON LINE if switch 9 is ON and disconnects otherwise.

During the past few years DOD has drawn attention to its increasing limited availability of highly skilled technical people. With the broadening use of telecommunications systems in the Services, the cross-section of users includes an ever increasing range of users from entry-level to the highly skilled. This software development acknowledges these evolutionary changes and was designed to achieve the following objectives:

* Capable of operation in an environment of constantly changing personnel.

* Minimize or eliminate the need for formal training.

* Require no technical expertise on the part of the user.

One of the benefits of this development has been that it has made evident the fact that different modems operate in different manners. As noted, given the same command, not only do they operate differently, but they also have syntax and register range settings differences as shown in the tables. Having designed this software package to accomodate these differences, we now have an experience base of cause-and-effect operating characteristics that impact system design. This experience base having extended our understanding of modem performance can form a basis for pursuing new areas of development.

MODEM TYPE	MODEM BAUD RATE		DATA LINK SPEED ESTABLISHED
	USED AT THE DIAL STATION	USED AT THE ANSWER STATION	
Both ends use same type of modem. Tested for U.S. Robotics 2400 Baud Sportster modem.	1200	1200	1200
	1200	2400	1200
	2400	1200	2400
	2400	2400	2400
One end uses different modem type than the other end. Tested for one end uses U.S. Robotics 2400 Baud Sportster modem and the other end uses SWAN 2400i modem	1200	1200	1200
	1200	2400	1200 OR 2400
	2400	1200	1200 OR 2400
	2400	2400	2400
One end uses modem that operates at only one speed Whereas the other end uses modem that operates at more than one speed. Tested for one end uses SWAN 2400i modem and the other end uses SIGNALMAN MARK XII modem. Also tested for one end uses SIGNALMAN MARK XII modem and the other end uses U.S. Robotics 2400 Baud Sportster.	* 1200	1200	1200
	* 1200	2400	1200
	1200	* 1200	1200
	2400	* 1200	1200
	* Modem that operates using only 1200 Baud Rate. No matter what its status (i.e., Dial station or answer station) the Baud Rate switched to 1200.		

TABLE 1

REGISTER FUNCTIONS	U.S. Robotics 2400 Baud Sportster	MultiModem 224E	SIGNALMAN MARK XII	SWAN 2400i
"S0"	Controls the number of rings after which an automatic answer will occur. Reset to zero at power up.	Controls the number of rings after which an automatic answer will occur. Reset to zero at power up.	Controls the number of rings after which an automatic answer will occur. Reset to one at power up.	Controls the number of rings after which an automatic answer will occur. Reset to zero at power up.
"S1"	Counts rings which have occurred	Counts rings which have occurred.	Reset to S0 value following AT command or at power up. Decrements each time the telephone rings	Counts rings which have occurred.
	Can be reset to zero while the phone is ringing	—	Can be reset to zero while the phone is ringing.	Can not be reset to zero while the phone is ringing.
"S7"	Determines how long modem will wait for carrier before aborting call. Range = (0-255) seconds	Determines how long modem will wait for carrier before aborting call. Range=(1-255) seconds.	Not available	Determines how long modem will wait for carrier before aborting call. Range=(1-30) seconds.

TABLE 2

MODEM COMMAND	U.S. Robotics 2400 Baud Sportster	MultiModem 224E	SIGNALMAN MARK XII	SWAN 2400i
DIAL TONE MODE	"W" is used to wait for a second dial tone,then continue dial string.	"B1" selects wait-for-tone dialing mode. "," in dial command causes modem to wait for another dial tone before resuming dialing	Not available	"W" is used to wait for the dial tone, then continue dial string.
REPEAT MODE	">" is used to enter the repeat mode. Repeat command execution until canceled by any key. Used with dial command, modem exits repeat mode after 10 failed dial attempts.	"A:" continuous redial of last number dialed until answered	Not available	Not available
AUDIO MONITOR CONTROL	"M0" monitor speaker always OFF	"M0" monitor speaker always OFF	Not available	"M0" monitor speaker always OFF
	"M1" speaker ON until carrier is established	"M1" speaker ON until carrier is established	Not available	"M1" speaker ON until carrier is established
	"M2" speaker always ON	"M2" speaker always ON	Not available	"M2" speaker always ON
	"M3" speaker ON after last digit dialed, OFF at carrier detect	Not available	Not available	Not available
ESCAPE CODE	"+++" if switch 9 ON, retains line connection,returns to command mode, sends "OK" result code. If switch 9 OFF, disconnects, returns to command mode, sends "NO CARRIER" result code.	"+++" brings modem into command mode while still remaining ON LINE.	"+++" brings modem into command mode while still remaining ON LINE.	"+++" brings modem into command mode while still remaining ON LINE.
RESULT CODES	"BUSY" result if the telephone number dialed is busy.	"BUSY" result if the telephone dialed is busy.	"NO CARRIER" if dialed telephone if busy.	"BUSY" result if the tele-phone number dialed is busy.

TABLE 3